



Test Report 21-295
26 December 2001

**ELECTROMAGNETIC INTERFERENCE
TEST REPORT
FOR THE
Capstone Turbine Corporation
Micro Turbine Model: 330**

PREPARED FOR
Capstone Turbine Corporation
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PREPARED BY
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RECORD OF CHANGES

REV	DATE	BY	REVISION DESCRIPTION	APPROVED
N/C	12-26-01		Original Issue	



SIGNATURE PAGE

The tests reported herein have been conducted by Nemko EESI, Inc., an independent test laboratory, in accordance with all applicable specifications, procedures and instructions as required by Capstone Turbine Corporation.

Tests Conducted By:

Bryce Elliott, Test Technician

Date

Gordon D. Levey, Test Engineer

Date

Report Approved for Nemko EESI, Inc. By:

Ricky Hill
Laboratory Manager

Date

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SUMMARY OF TEST RESULTS

The results of the testing are summarized in the following table.

TEST METHOD	RESULTS SUMMARY
ANSI C62.41 IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits and ANSI C62.45 IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits	Successfully completed. There was no evidence of susceptibility.

LIST OF ABBREVIATIONS AND ACRONYMS

µA	Micro ampere
µs	Micro seconds
µV	Micro volt
ac	alternating current
cm	centimeter
CTC	Current Transformer Cabinet Assembly
dB	Decibel
dc	direct current
EMI	electromagnetic interference
kHz	kilo Hertz
GHz	giga Hertz
ICC	Individual Control Cabinet
Jbox	Junction Box
m	meter
MHz	mega Hertz
MCC	Master Control Cabinet
rms	root mean square
RMS	Remote Maintenance Monitoring Subsystem
SL	Specification Limit
UUT	Unit Under Test
Vac	Volts ac rms
Vdc	Volts dc
Vp	Volts peak
Vp-p	Volts peak to peak
XFMR	Transformer
Z _t	Transfer Impedance



ELECTROMAGNETIC INTERFERENCE TEST REPORT

1 INTRODUCTION

1.1 Purpose

This document describes the Electromagnetic Interference testing of the Capstone Turbine Corporation, Micro Turbine Model: 330, over the period of April 2001 to June 2001.

1.2 Test Item Description

The Test item is as follows:

Micro Turbine Model: 330

The test items are also referred to as the units under test (UUT) or test sample throughout this report.

1.3 UUT Photograph



1.4 Manufacturer

Capstone Turbine Corporation
21211 Nordoff St.
Chatsworth, CA 91311

1.5 Quantity of Item Tested

One.

1.6 Security Classification

Unclassified

1.7 UUT Performance Monitor and Testing

Performance monitoring and testing of the test sample before, during, and after the EMI testing was performed by Capstone Turbine Corporation Representatives.

1.8 Disposition of Test Item

The test item was tested insitu at Capstone Turbine Corporation.

2 APPLICABLE DOCUMENTS

The following specifications and standards, of the issue noted, form a part of this document to the extent specified herein.

ANSI C62.41 IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

ANSI C62.45 IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits

3 TEST APPARATUS

3.1 General

In so far as practical, standard test conditions were maintained during the performance of all tests described herein. Laboratory environmental conditions were as follows:

Temperature: $25 \pm 10^\circ \text{C}$ ($77^\circ \text{F} \pm 18^\circ \text{F}$)
Humidity: 90% or less
Barometric Pressure: 28-32 inches Hg.

3.2 Test Facility

The UUT was tested insitu at Capstone Turbine Corporation, 6025 Yolanda Ave., Tarzana, CA 91356.

4 INSTRUMENTATION

4.1 Instrument Power

480 Vac, 60 Hz, three phase power required for the instrumentation was provided by Capstone Turbine Corporation.

4.2 Calibration

All measurement instruments used in determining compliance with the requirements specified herein, were maintained within a calibration system compliant to ANSI/NCSL Z540-1 and traceable to National Institute for Standards and Technology (NIST). Prior to each test, each instrument used, as applicable, was verified to be within its normal calibration period.

4.3 Test Instrument

Notes: Capstone Engineering

Test Equipment: April Test

1) Key Tek, Cat: 11-16-99 Due: 11-16-00
1) ECAT Control Center, F Class Series 100
S/N 9601191

2) Surge Network, Model E501
Combination Wave S/N 9907209
S/N 9504254 (entire rack)

3) Surge Network, Ring Wave, Model E503
S/N 9907196

4) Main Coupler/Decoupler, Model E4554
S/N 9908209
9607200

July Test

1) ECAT Control Center
S/N 9511192

2) Combination Surge Network E501/3
S/N 9907195

3) Ring Wave & Ring Surge Network E503
S/N 9904173

4) Main Coupler/Decoupler, Model E4554
S/N 9607200

August Test

1) ECAT Control Center Series 100
S/N 9601191

2) Combination Surge Network E501/3
S/N 9511180 Cat 12/10/00 Due 12/10/01

3) Ring Wave & Ring Surge Network E503
S/N 9511181 Cat 11/21/00 Due 11/21/01

4) Main Coupler/Decoupler Model E4554
S/N 9607200

330 EQUIP LIST

Notes: CAPSTONE ENGINEERING

TEST EQUIPMENT

JULY 2001

KEYTEK EQUIP; CAL 12/20/01 DUE

EQUIP # 10152468

MAIN UNIT

MATERIAL # KEYE103

SERIAL # 4500092837-10

EQUIP # 10152470

E501A

MATERIAL # KEYE501

COMBINATION WAVE

SERIAL # 4500092837-30

SURGE NETWORK

CAL DUE: 12-20-01

EQUIP # 10152472

E503

MATERIAL # KEYE503

100kHz RINGWAVE

SERIAL # 4500092837-50

SURGE NETWORK

CAL DUE: 12-20-01

EQUIP # 10152473

E4554KV

MATERIAL # KEYE4554

EFT/B

SERIAL # 4500092837-70

MAINS COUPLER

3-PHASE COUPLER/

DECOUPLER FOR ECAT

5 TEST CONDUCT

5.1.1 ANSI C62.41 IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits and ANSI C62.45 IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits

5.1.2 Requirement

The test is intended to demonstrate the compliance of the Equipment Under Test (E.U.T.) to electrical surge on supply lines.

5.1.3 Conduct

Testing was performed using the procedures specified in ANSI C62.41 IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits and ANSI C62.45 IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits. All combinations of the 3 phase 5 wire were performed.

5.1.4 Test Log

Notes: 1/30 START UP AT 13 BUMPS.
 EACH INCREMENT 7 MINES.

1200 BEGIN COMBINE MODE, COMB WAVE. N LO
 1245 BEGIN DIFF MODE, RING WAVE. N LO
 1330 BEGIN COMB MODE COMB WAVE. PE LO

6/6/01 1600 COMPLETE " " " " " 1000KV
 BEGIN RING WAVE PE LO

6/7 8:10 UNIT LOCKED IN "RIGHT DOOR NOT CLOSED MODE" REMEDY
 PROBLEM. UNIT WON'T TOGGLE TO 501A
 8:45 BEGIN 2000KV TEST IN RINGWAVE. 503A. TEST 8 SETS.
 9:30 REMEDY NETWORK PROBLEM. PUT UNIT IN 501A NETWORK
 MODE. CONTINUE 1000K Combination Wave w/501A.
 10:30 COMPLETE " " " " ".
 " ALL 1000K TEST. BEGIN 2000K TEST.
 10:40 BEGIN w/ 43N CIC2 PE ES01A

1205 ② FAULT 10019 + 2000KV 180° E 501A
 COMBINATION WAVE. C2L3 PE
 SYSTEM COOLDOWN FAULT 60010 90°
 1230 ② +2000KV E 501A C1N PE 180°
 1235 ② " " " 270°
 UNIT RESTARTS
 1405 INTERNAL FAULT 11001 +2000KV 360° E 501A
 1420 " " X 3
 FUEL FAULT - SYSTEM STANDBY.
 CUSTOMER TO REMEDY PROBLEM.
 1440 BACK ON LINE (3) INTERNAL FAULT 11001 -2000KV
 0° E 501A
 1450 FAULT FUEL 6006 - FLAME OUT. PROBLEM WITH
 PLANT FUEL/ELECTRICAL SYSTEM. CUSTOMER TO REMEDY
 PROBLEM.
 1545 INTERNAL FAULT 9015 (5)
 1550 " " 10038 FAST OVERVOLTAGE FAULT.
 1555 " " 11001 (6)
 1610 STOP FOR DAY

6/8 0800 CONTINUE TEST, UNIT STOPS AND RESTARTS,
 (AFTER 3.5 MINES) AT EVERY PULSE SUGAR. CUSTOMER
 INSTRUCTS TO CONTINUE TEST. I.E. PULSE AFTER START
 UP EACH TIME AND CONTINUE THROUGH TEST SEQUENCE.
 0930 COMPLETE 2000KV 501A. BEGIN PE-LO.
 BEGIN 2000KV-501A-N-LO. NO PROBLEMS WITH
 SHUT DOWN. UNIT STAYS ON THROUGH TEST WHEN
 NEUTRAL IS AT LO AND PE IS OFF. CUSTOMER
 SAYS TO PROCEED ON WITH NEUTRAL LOW THROUGH 6KV.

Notes: _____

6/10 0900 ARRIVE AT CAPSTONE. CUSTOMER DETAILED PROGRAM w/ E60. PROBLEM NOT RESOLVED.
 DECIDE TO SET UP 330 TO COMPLETE PREVIOUS TEST.
 1100 BEGIN 330 TEST AT RING WAVE, E503, +6000KV.
 1121 GRID FAULT 10019 - COMBINATION WAVE (E501A) +6KV.
 1400 COMPLETE TO NEUTRAL, COMBINATION AND RING WAVE, +6KV
 SET UP FOR C60 TEST. SET UP PROBLEM. CORRECTED
 WITH 330
 1425 - 330 SHUT DOWN (4) NO POWER COMBINATION WAVE, 0°
 -4KV L2N TO PE.

Notes: 6/19/01 0830 - SYSTEM ALMOST READY. CUSTOMER
 SETS UP GND AND SURGE SUPPRESSION.
 0900 BEGIN TEST ON 330. RING WAVE.
 TEST TO L2L3 N TO PE. E503 RING WAVE.
 6/20 0830 - SYSTEM CONNECTED OVER FROM MORNING.
 CAS TEST. BEGIN TEST AT 0845. CONTINUE RING WAVE.
 6/27 0815 - PROGRAM ECAT UNIT - RIGHT HAND DOOR #1
 OPENS. REACHED BY SLIDING DOOR OUT PATHWAY AND PUSHING
 DOOR/DRAWER BACK IN.
 1115 STOP TEST ON 330. CUSTOMER TO CHANGER MODULE,
 BEGIN/CONTINUE TEST ON C60. BEGIN WITH L1 TO PE E503
 6/29 START UP UNIT. BEGIN WITH +1000K +2000K,
 +4000K. UNIT STOPPED AT +6000K.
 0945 STOP TESTING. SAME TO CALL WHEN UP AND
 RUNNING.
 7/2 ARRIVE 1430. PERFORM SURGE TEST AT 6KV.
 UNIT SEEMS TO BE AFFECTED BY NEG 6KV.
 7/3 CONTINUE TEST AT 8AM. UNIT BEGINS TO
 SHUT DOWN AND RESTART WHEN PROGRAMMED IN L1 L2 N TO
 PE. NOTE: SURGE PEAKS: +2426/-696V +8/-21A
 WHEN SET UP TO DO L2 L3 N TO PE AT -6000
 VOLTS. UNIT DOES NOT SHUT DOWN WHEN
 IN +6000V MODE.
 AT +6000 - SURGE PEAKS +738/-1736V +28/-23A
 STOP TESTING -6000V BECAUSE OF CONTINUOUS
 SHUT DOWNS.

5.1.5 Test Matrix

Capstone Turbine Engineering
Model 330 Turbine Generator
Lightning Test, ANSI C62.41 & C62.45
Power: 277/480 VRMS, 60 Hz
Date: 18 April 2000

Differential Mode, Combination Wave

Notes: 1.) Add Hov protector - 2) Error 0019, T058 Delta Frequency
Auto restart successful, could not repeat 3) Same as 2)
except repeatable

Differential Mode, Ring Wave

Notes: ① Acid melt protectors
② GRID FAULT 10019, UNIT RESULTS.

Capstone Turbine Engineering
Model 330 Turbine Generator
Lightning Test, ANSI C62.41 & C62.45
Power: 277/480 VRMS, 60 Hz
Date: 19 April 2000

Common Mode, Ring Wave

Notes: 1) Add HV protection
2) (2009) IGBT, anti-resonants

**Capstone Turbine Engineering
Model 330 Turbine Generator
Lightning Test, ANSI C62.41 & C62.45
Power: 277/480 VRMS, 60 Hz
Date: 18 April 2000**

Common Mode, Combination Wave

Test Lead	+1 kV	-1 kV	+2 kV	-2 kV	+4 kV	-4 kV	+6 kV	-6 kV
L1L2 to PE	X	X	X	X	X	X	X	X
L2L3 to PE	X	X	X	X	X	X	X	X
L1L3 to PE	X	X	X	X	X	X	X	X
L1N to PE	X	X	X	X	X	X	X	X
L2N to PE	X	X	X	X	X	X	X	X
L3N to PE	X	X	X	X	X	X	X	X
L1L2L3 to PE	X	X	X	X	X	X	X	X
L1L2N to PE	X	X	X	X	X	X	X	X
L2L3N to PE	X	X	X	X	X	X	X	X
L1L3N to PE	X	X	X	X	X	X	X	X
L1L2L3N to PE	X	X	X	X	X	X	X	X

Notes: 1) Add MOV protector 2) Error 10019, EDSP Delta Frequency, Auto Restart Successful, could not restart 3) Unit flow sensor open - input faulted, Customer trouble shoot, replaced Digital Power Converter Board and IGBT Module, repeated test, results unit still damaged after test sequence later (4) UNIT SHUT DOWN - NO POWER
 5) UNIT SHUTS DOWN (9003) 6) 10018 GND FAULT 7) 9005 UNIT RESTARTS
 8) UNIT SHUTS DOWN, RESTART AND RESTARTS. 9) UNIT RESTARTS
 10) 5009 UNIT RESTARTS 11) 9006 RESTARTS 12) 2001 13) 2011

5.1.6 Test Results

The UUT successfully completed this test.